

PRINCETON UNIVERSITY
Department of Aerospace and Mechanical Sciences
Guggenheim Laboratories for the Aerospace Propulsion Sciences

6 July 1965

JP24 TRANSIENT PRESSURE MEASURING METHODS RESEARCH*

Status Report

for 1 April through 30 June 1965

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Research during the above period was directed for the most part toward the evaluation of cooled and uncooled small passage connected transducers. A special study of the dynamic performance of small passage connected transducers as affected by passage length and configuration was concluded and a technical note is in preparation. Efforts to improve upon the laboratory evaluation equipment and associated systems were made and work on the development of a computer program to yield phase and amplitude ratio vs frequency was intensified. Although rocket motor tests continued, emphasis was placed on the laboratory evaluation of the large number of transducers which became available during the last weeks of the research in an effort to complete as many evaluations as possible prior to releasing the equipment to Battelle Memorial Institute. Contact was maintained with instrument manufacturers, NASA technical personnel and other users of transducers. A smooth transition of the laboratory evaluation techniques is assured by the visits of personnel from the Battelle Memorial Insititue. It is expected that the laboratory equipment will be shipped early in July and that Battelle will be setup for evaluations sometime in August.

Transducer Evaluations

1. Dynisco Model PT134

Evaluation of the Model PT134 transducers has been greatly retarded due to electrical failure of the last available unit early in this research period. Laboratory evaluation and rocket motor tests, performed on a ceramic coated instrument returned to Princeton late in the period, again revealed a large amount of heat flow through the transducer body from the laboratory equipment and the uncooled rocket chamber wall. New instruments which have had the coolant passages modified are expected shortly and heat transfer studies will continue during July and August. A special water cooled adaptor,

FACILITY FORM 602

N 65 89167

(ACCESSION NUMBER)

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(PAGES)

CR-67193

(NASA CR OR TMX OR AD NUMBER)

(THRU)

(CODE)

(CATEGORY)

* This research is supported under NASA Contracts NASr-36 and NAS8-11216.

designed to control transducer environment is nearing completion and will be used as an aid in studying the heat transfer aspects of the cooled flush diaphragm transducers.

2. Kistler Instrument Corporation

(a) Model 616A

Rocket motor tests at 500 psig and 1200 psig chamber pressure and conditions of fully developed combustion instability, in which a copper-constantan thermocouple assembly replaced the Kistler 601A miniature quartz transducer in the 616A adaptor, revealed diaphragm temperatures exceeding that allowable for the 601A transducer. Following discussions with the manufacturer, it was decided that rocket testing for the model 616A would be carried to destruction of the transducer or adaptor. However, in the effort to complete as many laboratory evaluations as possible prior to removing the evaluating equipment to Battelle Memorial Institute, rocket motor testing was reduced to a minimum and the 616A assembly set aside for testing at a later date.

(b) Model 616H

Preliminary evaluation of the helium bleed versions of the Kistler 600 series assemblies was interrupted by the appearance of new and improved instruments and the recall of previous models of adapter/transducer assemblies on consignment to Princeton. A preliminary evaluation of the latest model 616H has been completed and rocket motor test data is currently being analyzed.

3. Aerojet General Corporation

(a) Model HB3X-1

A technical note on the extensive work done with this AGC version of the Princeton Small Passage Technique was prepared for distribution as Aeronautical Engineering Report No. 5950. A series of rocket motor tests at 500 psig and 1200 psig chamber pressure yielded very favorable results. Some erosion of the uncooled small passage probe occurred during testing and a small amount of thermal drift was noticed. Testing was performed without dynamic compensation and will resume with dynamic compensation after this terminal period of research.

(b) Model HB4X-1

A model HB4X-1, on consignment from Marshall Space Flight Center, has been evaluated. Dynamic testing in the laboratory yielded a higher amplitude ratio at a lower resonant frequency than the preceding HB3X-1 model. Time did not permit the construction of a compensating filter and rocket motor tests without dynamic compensation are in progress.

4. Elastronics EBL 609 N/P

Several attempts to evaluate this instrument in the laboratory, prior to rocket motor testing, were unsuccessful. One of two units failed during tests made to establish a coolant flow and coolant pressure rating. The second unit failed during static tests performed to accurately determine sensitivity, linearity, hysteresis, zero output shift with coolant pressure and zero output drift. Attempts to recover these instruments by ultra-sonic cleaning, vacuum-oven drying and curing in a dry box failed and further evaluation of the EBL 6009 N/P was abandoned.

5. Photocon Research Products

(a) Model PRP 395

A special model PRP 395 transducer assembly, bearing a cooled flame shield similar to the Model 352A previously evaluated in this research but greatly reduced in size, was evaluated in the laboratory. Static tests and response to a shock pressure input were satisfactory but dynamic response within the range of 500 cps to 10K cps was unsatisfactory. Since the transducer assembly was not a production instrument but a developmental item which apparently needed further modification, completion of the evaluation was deferred in favor of other work.

(b) Model PRP 200

The PRP 200, which utilizes an O-ring sealed ablative piston as a medium between the pressure source and a silicon semi-conductor strain gage transducer, exhibited undesirable acceleration effects when subjected to a shock pressure input and a poor dynamic response to a sinusoidal pressure source in the laboratory. Rocket motor tests will be made however to determine the effectiveness of the ablative piston with respect to heat flux capabilities.

Laboratory Equipment and Techniques

1. Small Passage Technique

The study of passage length and internal geometry effects on the dynamic performance of small passage connected transducers continued and a technical note (Aeronautical Engineering Report No. 595q) is in preparation.

The Princeton Advanced Cooled Probe Adaptor (GL029) yielded the expected good performance in the laboratory with a flat dynamic response to 2500 cps and a peak amplitude ratio of 11,500 cps. Mechanical failure of the cooled adaptor body from external pressure prevented rocket motor testing and the unit will be sectioned in an effort to determine the cause of failure.

2. Sinusoidal Pressure Generator

Some improvement in performance of the SPG resulted from reducing volume by inserting a stainless steel sleeve in the test chamber. However, undesirable frequencies probably originating in the extended passages to the inlet

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and outlet nozzles hampered test data analysis especially in determining phase vs frequency in small passage connected transducers. The sleeve was removed from the test chamber for the remainder of the research period and time did not allow for the design and manufacture of a new test chamber.

3. Shock Tube

Development of a computer program for determining phase and amplitude ratio vs frequency from photographed shock tube data displayed on an oscilloscope continued. Results of this effort will be published shortly in Aeronautical Engineering Report No. 595s.

Other Work

Several teflon-filled stainless steel spiral wound gaskets, developed previously in this research in cooperation with the Flexitallic Gasket Company, were coated with a .005 inch layer of Kel-F plastic to take up slight irregularities in transducer gasket seats and also to reduce the minimum required torque for satisfactory sealing. A number of gaskets without the filler material but coated with teflon were supplied by the above gasket company for testing.

A number of instruments and signal conditioning equipment were procured on a loan basis as an additional effort in improving upon laboratory evaluating equipment and techniques. These included power supplies, amplifiers, digital voltmeters, a phase meter and an oscilloscope.

Hardware necessary to adapt the latest transducers to laboratory equipment and to the rocket motors was designed and procured.

Time was given to bringing drawings, evaluating procedures and the Transducer Target Characteristics up to date. In addition, time was devoted to training and familiarizing Battelle personnel in the use of laboratory equipment and evaluating procedures and also to the preparation of operation and maintenance instructions. Although the effort to improve laboratory evaluation equipment was reduced, especially during the last month of the research, every effort was made to insure the satisfactory working condition of all equipment before removal to Battelle.